Original Research Article

A comparative clinical study to assess preinsufflation versus postdesufflation changes in arterial blood gas and pH in patients undergoing laparoscopic cholecystectomies under general anaesthesia

Shyambaran[1], Preeti Goyal[2], Seema Shende[3], Sourabh Shrivastava[4*], Dilip Kothari[5]

[1]Post Graduate Resident 3rd Year, Department of Anaesthesiology, Gajra Raja Medical College, Gwalior, Madhya Pradesh, India

[2]Designate Professor, Department of Anaesthesiology, Gajra Raja Medical College, Gwalior, Madhya Pradesh, India

[3]Associate professor, Department of Anaesthesiology, Gajra Raja Medical College, Gwalior, Madhya Pradesh, India

[4]Assistant Professor, Department of Anaesthesiology, Gajra Raja Medical College, Gwalior, Madhya Pradesh, India

[5]Prof. & HOD, Department of Anaesthesiology, Gajra Raja Medical College, Gwalior, Madhya Pradesh, India

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Abstract

Introduction: Pneumoperitoneum for laparoscopic surgeries leads to multiple changes in the mechanics of respiration and heart function. Arterial blood gas analysis can be used for the patients oxygenation, ventilation ,gas exchange and acid base homeostasis as well as to provide immediate information about electrolytes. **Aims:** To assess preinsufflation versus postdesufflation changes in arterial blood gas, pH, end tidal CO2 and hemodynamic parameters in patients undergoing laparoscopic cholecystectomies under general anaesthesia. **Material and methods:** 25-45 yrs of 80 patients, ASA grade I and II were randomly divided into two groups. Group1 –arterial blood sample was collected after 30 min of desufflation. Group 2- arterial blood sample was collected after 60 min of desufflation. Intraoperative monitoring of pulse rate, blood pressure (SBP, DBP, MBP), SpO2, and EtCO2 was done before and after induction, pre-insufflation, after creation of pneumoperitoneum and thereafter at interval of 5 minutes upto 30 minutes, then at 15 minutes interval till the end of surgery and continued for 30 minutes postoperatively. Arterial samples were collected before induction and in group I 30 minutes after desufflation and in group II 60 minutes after desufflation. **Result:** On comparison between two groups arterial blood gas analysis showed elevation in PaCO2 and reduction in pH more in group 1 (30 min after desufflation) than group 2 (60 min after desufflation). On intragroup comparison there were statistically highly significant increase in PaCO2 (42.99±0.78 Vs 38.03±0.96 in group 1, 42.61±1.06 Vs 39.14±1.05 in group 2) after desufflation as compared to preinsufflation values (p value < 0.000). There were statistically highly significant decrease in pH (7.40±0.02 Vs 7.42±0.02 in group 1, 7.41±0.01 Vs 7.42±0.01 in group 2) and bicarbonate (23.73±1.04 Vs 24.66±0.88 in group 1, 23.74±1.02 Vs 24.65±0.87 in group 2) after desufflation as compared to preinsufflation values (p value < 0.000). Heart rate, systolic, diastolic, mean arterial pressure and EtCO2 were statistically highly significant increase after insufflation and just after desufflation as compared to preinsufflation (p value < 0.000) in both groups (p value < 0.000). **Conclusion:** Pneumoperitoneum with CO2 insufflation caused significant increased in PaCO2, significant reduction in pH and bicarbonate in the postdesufflation period as compared to preinsufflation in both groups. There were also significant increase in heart rate ,systoloic, diastolic, mean arterial pressure and EtCO2 after CO2 insufflations and postdesufflation as compared to preinsufflation in both groups. There were statistically nonsignificant increase in PaCO2 and decrease in pH more in group 1 than group 2.

Keywords: pneumoperitoneum, arterial blood gas analysis, hemodynamic, preinsufflation, postinsufflation.

Introduction

Laparoscopic cholecystectomy is minimally invasive procedure for surgical removal of gall bladder. It involves insufflations of a gas into the peritoneal cavity to create pneumoperitoneum. Most commonly used gas for pneumoperitoneum is CO_2 because it is noninflammable, colourless, highly soluble in blood than air and its elimination can be augmented by increasing the minute volume. Effect of carbon dioxide, raised intraabdominal pressure and alteration in patient position causes physiological changes in cardiovascular and respiratory system. Pneumoperitoneum leads to multiple changes in the mechanics of respiration and heart function[1].It causes cranial dislocation of diaphragm, reduced lung compliance and lung volume and increase airway resistance, alters the ventilation/ perfusion (V/Q) ratio[2]. After insufflation CO2 diffuses throughout the tissue and absorbed through the peritoneal serosa which can causes hypercarbia and respiratory acidosis[3]. Hypercapnia stimulates the sympathetic nervous system leading to an increase in HR, BP, arrhythmias, myocardial contractility as well as it also sensitizes the myocardium to catecholamines[4]. Consequences of hypercapnia are rapid breathing, tachycardia, headache, dizziness, flushed skin and confusion. In severe case disorientation, convulsion, unconsciousness, and death may occur.

*Correspondence
Dr. Sourabh Shrivastava
Assistant Professor, Department of Anaesthesiology, Gajra Raja Medical College, Gwalior, Madhya Pradesh, India.
E-mail: sourabh_jitu@ymail.com

Arterial blood gas analysis can be used for the patients oxygenation, ventilation, gas exchange and acid base homeostasis as well as to provide immediate information about electrolytes[5]. Various studies have been done on changes in arterial blood gas concentration and haemodynamic due to creation of pneumooperitoneuem but the time to achieve normal CO2 concentration post desufflation is still controversial. So we have planned a study to assess preinsufflation versus postdesufflation changes in arterial blood gas and pH in patients undergoing laparoscopic cholecystectomies under general anaesthesia.

Material and method

After obtaining approval from ethical committee, the present prospective randomized controlled study was conducted in Department of Anaesthesiology, J.A. Group of Hospitals and G.R. Medical College, Gwalior during Nov2019 –June 2021. 80 patients of age between 25-45 years of either sex of American Society of Anaesthesiology grade I and II weighing between 45-70 kg were included in this study. Patients of American Society of Anaesthesiology grade III and IV and with any systemic respiratory, cardiovascular, renal diseases, obesity and pregnancy were excluded from the study. Complete preanaesthetic check up of these patients had been done. Informed written consent were taken, subsequently patients were randomized into two groups of 40 each. Randomisaton done on the basis of systemic sampling method.

Group1 –arterial blood sample was collected after 30 min of desufflation.

Group 2- arterial blood sample was collected after 60 min of desufflation.

Sample size

80 patients

Based on Formula used: $\mathbf{n = \frac{(Z_{\alpha} + Z_{1-\beta})^2}{(\Delta/E)^2}}$

Where alpha is error

Beta is power

E is estimated precision

After complete routine preanaesthetic assessment, patient was taken in Operation theatre. Drager Scio Four Plus Monitor was attached and baseline parameters were recorded (Pulse rate, SBP, DBP, MBP and SPO2). Intravenous line was secured and all the patients were uniformly premedicated with Inj. Glycopyrrolate 0.2 mg intravenously, Inj. Pentazocine 0.3-0.6 mg/kg intravenous was given as an analgesic.

Preoperative arterial blood sample was collected just before induction after local infiltration with 2% xylocaine from radial artery in a preheparinised 2ml syringe and samples tested for arterial blood gases.. Preoxygenation was done with 100% O2 for 3 minutesand all patient were induced with Inj. Sodium Thiopentone 5mg/kg and intubation performed with appropriate sized cuffed endotracheal tube after Inj. Succinylcholine 1.5mg/kg. Anesthesia was maintained with 66% N2O and 33% O2 with Isoflurane and relaxation maintained with intermittent Inj. Atracurium 0.1 mg/kg and IPPV maintained with tidal volume 6-8ml/ predicted body kg and respiratory rate 15/min, using DragerFabius GS Primium ventilator. Residual effect was reversed by Inj. Neostigmine 0.04-0.08mg/kg and Inj. Glycopyrrolate 0.5mg intravenously and patient extubated after return of reflexes and proper suctioning.Introperative monitoring and recording of pulse rate, blood pressure (SBP, DBP, MBP), SpO2, and EtCO2 was done at just after induction, pre-insufflation, after creation of pneumoperitoneum and thereafter at interval of 5 minutes upto 30 minutes, then at 15 minutes interval till the end of surgery and continued for 30 minutes postoperatively. In half of the patients arterial blood samples were collected after 30 minutes and in remaining half after 60 minutes of desufflation.

Statistical analysis

The statistical analysis of this study was carried out by paired t test. p value > 0.05 was statistically insignificant, p value < 0.05 was statistically significant and p value <0.01 was statistically highly significant The statistical analysis was done using SPSS software (Version20).

Results

Table 1: Demographic distribution

Age Group	Group 1 (N=40)	Group 2 (N=40)
25-30 Year	9 (22.5%)	12 (30%)
30-40 Year	13 (32.5%)	13 (32.5%
40-45 Year	18 (45%)	15 (37.5%)
Mean±SD	37.37±11.07	37.55±13.64
SEX		
Male	8 (20%)	10 (25%)
Female	32 (80%)	30 (75%)
Weight		
45-60 Kg	20	24
60-70 Kg	20	16
Mean±SD	59.3±3.36	58.02±2.97
Height		
60-63	24	18
64-67	16	22
Mean±SD	63.15±1.51	63.5±1.58

There was no statistically significant difference in terms of demographic parameters in both groups**.**

Table 2: Comparison of Arterial blood gas and pH in two groups at different time

Arterial Blood Gas Analysis	Group 1			Group 2		
	Pre-induction	30 minutes after de-sufflation	p-value	Pre-induction	60 minutes after de-sufflation	p-value
PaCO2	38.03±0.96	42.99±0.78	<0.000***	39.14±1.05	42.61±1.06	<0.000***
HCO3	24.66±0.88	23.73±1.04	<0.000***	24.65±0.87	23.74±1.02	<0.000***
pH	7.42±0.02	7.40±0.02	< 0.000***	7.42±0.01	7.41±0.01	< 0.004***

p *** <0.01-highly statisticaly significant ,p**<0.05- statistically significant, p* >0.05 - statistically insignificant

On intragroup comparison there were statistically highly significant difference in PaCO2, bicarbonate and pH after desufflation as compared to preinsufflation in both groups (p value <0.01)

Table 3: Inter group comparison of Arterial Blood Gas and pH in two groups at before Induction and after 30 min in group 1 and after 60 min in group 2

Arterial Blood Gas Analysis	Pre-induction Group 1	Pre-Induction Group 2	p-value	30 minutes after de-sufflation Group 1	60 minutes after de-sufflation Group 2	p-value
PaCO2	38.03±0.96	39.14±1.05	<0.072*	42.99±0.78	42.61±1.06	<0.138*
HCO3	24.66±0.88	24.65±0.87	<0.214*	23.73±1.04	23.74±1.02	<0.151*
pH	7.42±0.02	7.42±0.01	< 0.479*	7.40±0.02	7.41±0.01	< 0.246*

p *** <0.01-highly statisticaly significant ,p**<0.05- statistically significant, p* >0.05 - statistically insignificant

On intergroup comparison there were no statistically significant difference in PaCO2, bicarbonate and pH between two groups (p value >0.05)

Table 4: Inter and Intragroup Statistical Analysis of Mean (±SD) Pulse Rate (bpm) in Two Study Groups

S.No.	Time(Minutes)	Pulse Rate (bpm)		
		Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	p-value
1	**Pre insufflations**	75.42±5.22	78.15±5.96	0.046**
2	**After insufflation**	81.17±5.38	83.22±4.44	0.097*
3	**Post de-sufflation***	86.52±5.67	89.12±2.67	0.011**
p-value		<0.000***	<0.000***	

p *** <0.01-highly statisticaly significant ,p**<0.05- statistically significant, p* >0.05 - statistacally insignificant

On intragroup comparison there was statistically highly significant increase in pulse rate after insufflation and postdesufflation as compared to preinsufflation in both groups (p value <0.000).

On intergroup comparison there was statistically significant difference in pulse rate after desufflation between two groups (p value =0.011)

Table 5: Inter and Intra group Statistical Analysis of Mean (±SD) SBP, DBP and MAP in Two Study Groups

S. No.	Time (Minutes)	SBP			DBP			MAP		
		Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	p-value	Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	p-value	Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	p-value
1	**Preinsufflations**	111.0±5.57	110.4±7.51	0.412*	78.75±5.90	77.77±5.93	0.199*	89.90±4.70	88.13±4.70	0.168*
2	**After insufflation**	118.1±5.80	118.7±5.26	0.490*	83.55±5.79	83.02±5.49	0.311*	95.05±3.89	95.23±4.14	0.466*
3	**Post desufflation***	117±5.18	115.7±5.80	0.333*	79.67±6.20	80.35±3.97	0.578*	92.2±4.40	92.05±3.32	0.954*
p-value		<0.000***	<0.000***		<0.000***	<0.000***		<0.000***	<0.000***	

p *** <0.01-highly statisticaly significant ,p**<0.05- statistically significant, p* >0.05 - statistically insignificant

On intragroup comparison there were statistically highly significant increase in SBP, DBP and MAP after insufflation and postdesufflation as compared to preinsufflation in both groups (p value <0.000).

On intergroup comparison there were no statistically significant difference in SBP, DBP and MAP after insufflation and postdesufflation between two groups(p value >0.05).

Table 6: Inter and Intra group Statistical Analysis of Mean (±SD) EtCO2 in Two Study Groups

S.No.	Time (Minutes)	EtCO2		
		Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	p-value
1	**Pre insufflations**	35.7±0.99	35.72±0.87	1*
2	**After insufflation**	39.67±1.14	39.30±1.06	0.108*
p-value		<0.000***	<0.000***	

p *** <0.01-highly statisticaly significant ,p**<0.05- statistically significant, p* >0.05 - statistically insignificant

On intragroup comparison there was statistically highly significant increase in EtCO2 after insufflation as compared to preinsufflation in both groups (p value <0.000).

On intergroup comparison there was no statistically significant difference in EtCO2 after insufflation between two groups (p value =0.108).

Discussion

Laparoscopic surgery causes small incision, less pain, less discomfort, less scarring, fast recovery, earlier discharge, lesser postoperative complication, rapid return to normal activities, less postoperative wound infection reduced postoperative pain and analgesic requirements[6]. Laparoscopic cholecystectomy involves insufflations of a gas into the peritoneal cavity under pressure (IAP usually 12-14 mmHg) to separate the organs from the abdominal wall to create a pneumoperitoneum. After insufflation CO2 diffuses throughout the tissue. CO_2 can be absorbed through the peritoneal serosa which can causes hypercarbia and respiratory acidosis. The absorbed CO2 can causes hypercapnia which stimulates the sympathetic nervous system leading to an increase in HR, BP, arrhythmias ,myocardial contractility as well as it also sensitizes the myocardium to catecholamines [4]. Consequences of hypercapnia are rapid breathing, tachycardia, headache, dizziness, flushed skin and confusion. In severe case disorientation, convulsion, unconsciousness, and death may occur.Arterial blood gas analysis can be used for the patients oxygenation, ventilation, gas exchange and acid base homeostasis as well as to provide immediate information about electrolytes[5].

In our study we found that in both groups on intragroup comparison heart rate , SBP, DBP and mean arterial pressure were statistically highly significant increased after desufflation and after CO2 insufflation as compared to preinsufflation (P value <0.000, highly significant). On intergroup comparison there were no statistically significant difference in SBP, DBP and MAP after insufflation and after desufflation between two groups (p value >0.05) but statistically significant difference found in heart rate after desufflation (p value

=0.011).These changes were due to CO2 absorption through the peritoneal serosa during CO2 insufflation and causes stimulation of sympathetic nervous system. We found that preinsufflation PaCO2 value was 38.03±0.96 in group 1 and 39.14±1.05 in group 2. On intergroup comparison we found no statistically significant difference in PaCO2 (P value <0.138).

In group 1 preinsufflation PaCO2 level was 38.03±0.96 and postdesufflation PaCO2 level was 42.99±0.78. On intragroup comparison we found statistically highly significant difference in PaCO2 (P value <0.000).

In group 2 preinsufflation PaCO2 level was 39.14±1.05 and postdesufflation PaCO2 level was 42.61±1.06. On intragroup comparison we found statistically highly significant difference in PaCO2 (P value <0.000).

We found that preinsufflation pH value was 7.42±0.02 in group 1 and 7.42±0.01 in group 2 . On intergroup comparison we found no statistically significant difference in pH (P value <0.246).

In group 1 preinsufflation pH value was 7.42±0.02 and post desufflation pH value was 7.40±0.02. On intragroup comparison we found statistically highly significant difference in pH (P value <0.000). In group 2 preinsufflation pH value was 7.42±0.01 and postdesufflation pH value was 7.41±0.01. On intragroup comparison we found statistically highly significant difference in pH (P value <0.004). We found that preinsufflation bicarbonate level was 24.66±0.88 in group 1 and 24.65±0.87 in group 2. On intergroup comparison we found no statistically significant difference in bicarbonate (P value < 0.151).

In group 1 preinsufflation bicarbonate level was 24.66±0.88 and postdesufflation bicarbonate level was 23.73±1.04. On intragroup comparison we found statistically highly significant difference in bicarbonate (P value <0.000).

In group 2 preinsufflation bicarbonate level was 24.65±0.87 and postdesufflation bicarbonate level was 23.74±1.02. On intragroup comparison we found statistically highly significant difference in bicarbonate (P value <0.000).

We found that on intragroup comparison in group 1 EtCO2 level was statistically highly significant increase during CO2 insufflation (39.67±1.14) as compared to preinsufflation level (35.7±0.99).

We found that on intragroup comparison in group 2 EtCO2 level was statistically highly significant increase during CO2 insufflation (39.30±1.06) as compared to preinsufflation level (35.72±0.87).

On intergroup comparison we found that no statistically significant difference in EtCO2 in both groups at after insufflation (p value = 0.108). **Bhadauria A S** et al found that the significant increased in heart rate 90 min after CO2 insufflation but decreased significantly after release of pneumoperitoneum. The SBP, DBP and mean arterial pressure were statistically significant increased during CO2 insufflation and after desufflation as compared to preinsufflation values. Authors also found that the etco2 and paco2 values were statistically significant increased during CO2 insufflation and after desufflation as compared to preinsufflation. The pH was decreased significantly during CO2 insufflation and after desufflation and 30 min after extubation in the recovery room as compared to preinsufflation [7]. **Shobhana G** et al noted that there were significant increased in EtCO2 (p=0.002) and significant reduction in pH (p<0.05) after desufflation as compared to preinsufflation level. There were insignificant increased in Paco2 (p>0.05) and HCO3 (p>0.05) after desufflation as compared to preinsufflation. Both the systolic and diastolic blood pressure were increased after CO2 insufflation and postdesufflation as compared to preinsufflation. The heart rate showed non significant change. **Hakeem A** et al noted that there were statistically significant increased in PaCO2 and EtCO2 during CO2 insufflation (p<0.05). The pH was significantly decreased during CO2 insufflation (p<0.05) as compared to preinsufflation level. Bicarbonate decreased over period of time and peak drop was observed at 30 min after CO2 insufflation (p=0.199).**Kanzarkar U M and Savargaonkar A** observed that the statistically highly significant decreased in pH (7.41±0.03 vs 7.37±0.04) and highly significant increased in Paco2 (40.52±4.19 mmHg vs 36.73±3.96 mmHg) during pneumoperitoneum as compared to preinsufflation values. Base excess was highly significant decreased during pneumoperitoneum as compared to preinsufflation level. bicarbonate concentration showed no significant changed during pneumoperitoneum[7]

Conclusion

Pneumoperitoneum with CO2 insufflation caused significant increase in heart rate, systoloic, diastolic and mean arterial pressure after insufflation and postdesufflation as compared to preinsufflation. EtCO2 was statistically highly significant increase after CO2 insufflation as compared to preinsufflation. These changed were due to CO2 absorption through the peritoneal serosa and intraabdomianal pressure. There were also significant increase in PaCO2 and significant reduction in pH and bicarbonate in the post desufflation period as compared to preinsufflation. Elevtion in PaCO2 was more in group 1 than group 2 which was statistically nonsignificant and reduction in pH was more in group 1 than group 2 which was statistically nonsignificant.

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